

**Visions of Visualization Aids:
Design Philosophy and Experimental Results**

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Aids for the visualization of high-dimensional scientific or other data must be designed. Simply casting multidimensional data into a two- or three-dimensional spatial metaphor does not guarantee that the presentation will provide insight or parsimonious description of the phenomena underlying the data. Indeed, the communication of the essential meaning of some multidimensional data may be obscured by presentation in a spatially distributed format.

Useful visualization is generally based on pre-existing theoretical beliefs concerning the underlying phenomena which guide selection and formatting of the plotted variables. Two examples from chaotic dynamics are used to illustrate how a visualization may be more than a pretty picture but rather an aid to insight.

Dynamic visual displays can help understand how simulation parameters change with time and conditions but purely visual analysis is dependent upon a subjective perceptual assessment of the display. The hope is that a viewer can see new phenomena in the map of the data space that the display provides. The presumption that simple visual inspection of the displays will provide insight into the simulation, and especially reveal new phenomena, however, assumes the displayed images will be visually comprehensible. This comprehensibility, however, depends upon the appropriateness of the selections of axes and the inherent dimensionality of the phenomena to be uncovered. More specificity, if the display is to be more illuminating than confusing, at least its dimensionality must match the dimensionality of the phenomena. Anyone who has ever seen a dynamic two-dimensional projection of an irregularly tumbling four-dimensional cube will quickly appreciate the thrust of this requirement.

Visualization tools are particularly useful for understanding inherently three-dimensional databases such as those used by pilots or astronauts during aircraft or spacecraft maneuvers. Two examples of displays to aid spatial maneuvering will be described. The first, a perspective format for a commercial air traffic display, illustrates how geometric distortion may be introduced to insure that an operator can understand a depicted three-dimensional situation. The second, a display for planning small spacecraft maneuvers, illustrates how the complex counterintuitive character of orbital maneuvering may be made more tractable by removing higher-order nonlinear control dynamics, and allowing independent satisfaction of velocity and plume impingement constraints on orbital changes.

References

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